Original paper

Adequacy of Glycaemic Control and Knowledge of Diabetes among Ambulatory Patients with Type 2 Diabetes at Mbagathi Hospital, Nairobi, Kenya

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Abstract

Background: Diabetes mellitus is associated with high morbidity, premature mortality and socio- economic burden globally. Its complications, morbidity and premature mortality can be delayed or prevented by optimal glycaemic control. Knowledge of diabetes plays an integral role in attaining desirable diabetes self-care and clinical outcomes. However, despite Diabetes Self-Management Education (DSME) and advances in treatment, diabetes is often inadequately controlled in clinical practice.

Objective: To determine adequacy of glycaemic control and knowledge of diabetes among ambulatory patients with Type 2 Diabetes Mellitus (T2DM) at Mbagathi Hospital, Nairobi, Kenya.

Design: Cross-sectional descriptive study.

Setting: Diabetes outpatient clinic, Mbagathi Hospital, Nairobi, Kenya.

Subjects: One hundred and sixty five patients with T2DM, aged ≥ 40 years, selected by simple random sampling, each on one anti-diabetes regimen for a period of not less than 3 consecutive months.

Methods: The study was undertaken over a period of six months from June 2015 during routine diabetes clinics. Glycaemic control and knowledge of diabetes were assessed using HbA1c assay and MDRTC diabetes knowledge test questionnaire respectively. The 4-point modified Morisky Medication Adherence Scale was used to determine adherence to medication.

Results: Of the 165 patients with T2DM recruited, 66.1% were females. Mean age (±SD) was 55.7 ± 9.5 years. Literacy level was 93.3%. The study population was largely of low socio-economic status. Mean (± SD) HbA**1**c level was high, 9.5 ± 3.1%. Mean DKT score (±SD) was satisfactory, 64.3 ± 15.3%. Levels of glycaemic control and knowledge of diabetes were 25.5% and 90.9% respectively. Adherence to medication was low (37.6%). Knowledge deficits were identified in areas related to diet, treatment of hypoglycaemia and effect of physical activity on blood glucose.

Glycaemic control was significantly associated with single (marital) status (p = 0.005), formal employment (p = 0.05), and diabetes education acquired over one year prior to study entry (p = 0.014). Knowledge of diabetes was associated with female gender (p = 0.025) and unemployment (p = 0.045). Adherence to medication was not associated with glycaemic control and knowledge of diabetes (p >0.05). However, there was association of non-adherence to medication with low family income (p = 0.043), provision of medication by spouses (p = 0.030), diabetes education gained 7-12 months prior to study entry (p = 0.031) and multiple anti-diabetes drug regimens (p = 0.004).

Sub-optimal glycaemic control was possibly due to low socio-economic status, impacting on adherence to diabetic diet and medication. Association of glycaemic control and formal employment was attributed to ability of employed patients to afford cost of medical care, while association of glycaemic control and diabetes education acquired over one year prior to study entry was likely due to adequate exposure to diabetes education and appropriate use of internalized knowledge of diabetes. Knowledge of diabetes was associated with female gender probably due to the postulated better health-seeking habits of females. Association of knowledge of diabetes and unemployment may have been because the unemployed devoted ample time to acquire knowledge of diabetes. Non-adherence to medication was associated with low family income and multiple anti-diabetes drug regimens most likely due to inability to meet cost of medication. Association of non-adherence to medication with diabetes education gained 7-12 months prior to the study entry was probably due to inadequate knowledge of diabetes acquired.

Conclusion: There was evident dissociation of glycaemic control and knowledge of diabetes. Therefore it is essential that factors affecting glycaemic control and adherence to medication as well as the identified knowledge deficits should be promptly addressed, as re-enforcement of knowledge of diabetes is maintained.

Key words: Type diabetis mellitus, Glycaemic control

Introduction

Among the environmental risk factors that predispose to T2DM, the major factors are over-nutrition and sedentary lifestyle. These predispose to overweight and obesity, which in turn lead to T2DM. Worldwide diabetes poses substantial morbidity and premature mortality, as well as public health and socio-economic burden due to its long-term complications (1,2). The risk for these complications is related to overall glycaemic burden over time (2). Diabetes treatment is based on the rationale that controlling blood glucose to near normal range is the primary strategy that reduces or prevents diabetes complications, morbidity and premature mortality (3,4). Knowledge of diabetes, an integral component in diabetes care that influences change of attitude and practice, targets glycaemic control and thus minimizes the complications. Knowledge of diabetes is gained through Diabetes Self-Management Education (DSME) program (5).

An estimated 415 million adults (aged 20-79 years) had diabetes mellitus globally in the year 2015, 75% of whom were in developing resource-poor countries. This figure was projected to rise to a staggering 642 million people by 2040 (6), if risk factors for diabetes are not addressed. Kenya with an estimated prevalence of diabetes of 3.3%, had 1.8 million people with diabetes in 2015; the prevalence of diabetes was expected to increase to 4.5 % by 2025 (7). A sum total of US$ 673.0 billion was expended on diabetes-related healthcare globally in 2015, and the expenditure was anticipated to be in excess of US$ 802.0 billion by 2040 (6).

Several studies in developing (8-12) and developed countries (13) have documented sub-optimal glycaemic control among most patients with T2DM. Poor patient knowledge of diabetes has also been demonstrated (14). This study aimed to determine adequacy of glycaemic control, knowledge of diabetes, knowledge deficits and adherence to medication among the ambulatory adults with T2DM in a managed healthcare setting as an audit of glycaemic control.

Materials and methods

Study setting and recruitment: This was a cross-sectional descriptive study conducted from June 2015 through November 2015 in the diabetes outpatient clinic at Mbagathi Hospital, an urban secondary referral healthcare facility. A total of 165 patients with T2DM were recruited by simple random sampling. Inclusion criteria were patients aged ≥ 40 years, diabetes mellitus documented by WHO diagnostic criteria (15), one continuing prescription for diabetes treatment for a period of not less than three consecutive months prior to study entry, ability to understand and speak English and or Kiswahili and a duly signed informed written consent to participate in the study. Exclusion criteria were documented T1DM, severe illness or cognitive impairment and pregnancy. Instruments used for data collection were glycosylated haemoglobin A1c (HbA1c) assay (16,17), Michigan Diabetes Research and Training Centre (MDRTC) diabetes knowledge test questionnaire (18) and the 4-point modified Morisky Medication Adherence Scale (MMAS-4) (19). The questionnaires were administered by investigators to ensure that, through standardized explanations, patients understood the questions before answering them. HbA1c assay and the MDRTC diabetes knowledge test were employed to assess glycaemic control and level of knowledge on diabetes respectively. HbA1c assay provides information about the degree of long-term glucose control; it reflects mean blood glucose over the previous 8 - 12 weeks (16,17). The MDRTC diabetes knowledge test, a two-part 23-item questionnaire developed by the Michigan Diabetes Research Training Centre (US), assesses general knowledge of diabetes. Its first 14 questions are relevant to patients not on insulin therapy (most patients with T2DM), while the entire 23-item questionnaire is applicable to insulin-treated patients. The rationale for use of the MDRTC diabetes knowledge test questionnaire includes its reliability and validity as a research instrument (20). This study used the 14-item MDRTC diabetes knowledge test, which can be administered in about 15 minutes. The MMAS-4 is a structured 4-item self-reported adherence measure that assesses medication adherence.

Data analysis: Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) version 21.0 software. Continuous data, e.g., age and HbA1c, were summarized in means, medians and Standard Deviation (SD), while categorical data, e.g., sex, marital status were summarized in frequencies and percentages. Glycaemic control was evaluated as mean HbA1c level, categorized into good control (HbA1c ≤ 7%) and poor control (HbA1c > 7%), and presented as percentage with 95% Confidence Interval. Knowledge of diabetes was worked out as mean MDRTC diabetes knowledge test score and categorized into good knowledge (DKT score ≥ 50%) and poor knowledge (DKT score < 50%). MMAS-4 score of zero was considered good adherence to medication, and MMAS-4 score 1 - 4 as poor adherence (or non-adherence) to medication.

Results

Socio-demographic characteristics of the patients are shown in Table 1. There was female predominance (66.1%). Mean age of the patients (± SD) was 55.7 ± 9.5

years, and median duration of diabetes was 3.0 years (IQR 1.0 - 7.0). Literacy level was at 93.3%. The vast majority (85.5%) of the patients had basic education. About 61% of the patients were employed. However, the study population was largely of low income status, with only 6.7% in the family annual pre-tax income bracket in excess of Kshs.150,000.00 (US$ 1 was equivalent to Kshs. 107.00). Mean HbA1c was 9.5%, a level higher than the recommended desired target of optimal glycaemic control by ADA, HbA1c < 7%. Other demographics are shown in Table 1.

Table 1: Distribution of socio-demographic characteristics of the patients

Characteristic	Frequency, *n* (%)
Mean (±SD) age in years (range in years)	55.7 ± 9.5 (40 - 89)
Gender	
Male	56 (33.9)
Female	109 (66.1)
Marital status	
Single	21 (12.7)
Married	127 (77.0)
Divorced/separated	5 (3.0)
Widowed	12 (7.3)
Level of formal education	
Formal education	11 (6.7)
Primary School education	97 (58.8)
Secondary School education	44 (26.7)
Tertiary education (College/University)	13 (7.9)
Employment	
Unemployed	65 (39.4)
Formal employment	29 (17.6)
Informal employment	71 (43.0)
Family annual income, Ksh. *(pre-tax income from all sources)*	
≤ 50,000.00	113 (68.5)
50,001.00 - 100,000.00	31 (18.8)
100,001.00 - 150,000.00	10 (6.1)
> 150,000.00	11 (6.7)
Who buys medication	
Self	128 (77.6)
Spouse	14 (8.5)
Child	19 (11.5)
Employer/Health Insurance Company	4 (2.4)

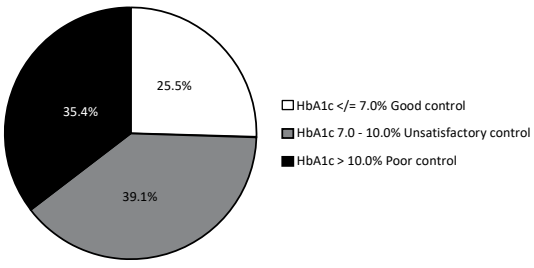
Table 2 shows diabetes-related characteristics of the patients. Most (92.1%) of the patients received DSME, the bulk of whom (70.9%) six months prior to their study entry. Almost 8% of the patients did not access diabetes education at all, while 15% did not have periodic training to re-enforce DSME for a period exceeding one year. About 85% of the patients were on oral hypoglycaemic agents (OHAs) for control of blood glucose, while only 15% were on insulin with or without metformin. Other characteristics were as shown in Table 2.

Table 2: Distribution of the diabetes-related characteristics of the patients

Characteristic	Frequency, *n* (%)
Median duration of diabetes in years (interquartile range, IQR) Range of duration of diabetes in years	3.0 (1.0 - 7.0) 3 months - 26 years
Family history of diabetes	
Yes	77 (46.7)
No	88 (53.3)
Diabetes education/update sessions	
None since diagnosis	13 (7.9)
≤ 6 months prior to recruitment into the study	117 (70.9)
7-12 months prior to recruitment into the study	10 (6.1)
> 1 year prior to recruitment into the study	25 (15.2)
Self-monitoring blood glucose (SMBG), glucometer utilization	
Yes	57 (34.5)
No	108 (65.5)
Anti-diabetic medications used	
Oral hypoglycaemic agent(s): Metformin ± Glibenclamide or Gliclazide	140 (84.9)
Insulin only	6 (3.6)
Insulin and oral hypoglycaemic agent: Insulin + Metformin	19 (11.5)
Median number of anti-diabetic drugs (interquartile range , IQR)	2 (1 - 2)

Figure 1 illustrates glycaemic control among the study patients. Adequacy of glycaemic control was low, at 25.5% (HbA1c < 7%). M:F 1:2. Females constituted 65.9% of the patients with poor glycaemic control (HbA1c > 7%). Over a third of the patients (35.4%), corresponding to nearly a half of the poorly controlled patients, had HbA1c level > 10%. Mean HbA1c (± SD) was 9.5 ± 3.1%, range 5.02% - 18.12%.

Figure 1: Glycaemic control among the study patients



Mean fasting blood glucose level was 10.9 mmol/l, range 3.7 - 32.7 mmol/l. Close to a quarter of the patients (26.1%) had normal blood glucose (<7.0 mmol/l). There were disparities in levels of HbA1c and fasting blood glucose in 20% of the patients. Slightly over one tenth of the patients (10.3 %) had normal HbA1c (≤ 7.0 %) and high blood glucose (≥ 7.0 mmol/l), while less than one tenth of the patients (9.7%) had high HbA1c (> 7.0 %) and normal blood glucose (< 7.0 mmol/l).

Table 3 describes association of glycaemic control with socio-demographic characteristics. Multivariate analysis revealed statistically significant difference in glycaemic control between the patients who were single and the married, p = 0.005 (OR 3.9, 95% CI, 1.5 to 10.1), suggesting glycaemic control was significantly associated with single (marital) status. There was also significant difference in glycaemic control between the patients in formal employment and the unemployed, p = 0.05 (OR 2.6, 95% CI, 1.0 - 6.6), suggesting glycaemic control was significantly associated with formal employment.

Table 3: Association of glycaemic control with socio-demographic characteristics

Characteristic	Controlled glycaemia (HbA1c ≤ 7.0) *n* (%)	Uncontrolled glycaemia (HbA1c > 7.0%) *n* (%)	OR (95% CI)	P-value
Gender				
Male	14 (25.0)	42 (75.0)	1.0	
Female	28 (25.7)	81(74.3)	1.0 (0.5 - 2.2)	0.923
Marital status				
Single	11 (52.4)	10 (47.6)	3.9 (1.5 - 10.1)	0.005
Married	28 (22.0)	99 (78.0)	1.0	
Separated/divorced	0 (0.0)	5 (100.0)	-	0.999
Widowed	3 (25.0)	9 (75.0)	1.2 (0.3 - 4.6)	0.814
Level of formal education				
No education Primary education Secondary education Tertiary education	2 (18.2)	9 (81.8)	1.0	
	21 (21.6)	76 (78.4)	1.2 (0.2 - 6.2)	0.790
	14 (31.8)	30 (68.2)	2.1 (0.4 - 11.0)	0.381
	5 (38.5)	8 (61.5)	2.8 (0.4 - 18.7)	0.285
Employment				
Unemployed	14 (21.5)	51 (78.5)	1.0	
Formal employment	12 (41.4)	17 (58.6)	2.6 (1.0 - 6.6)	0.050
Informal employment	16 (22.5)	55 (77.5)	1.1 (0.5 - 2.4)	0.889
Family annual income (KES)				
≤ 50,000.00	27 (23.9)	86 (76.1)	1.0	
50,001.00 - 100,000.00	10 (32.3)	21 (67.7)	1.5 (0.6 - 3.6)	0.347
100,001.00 - 150,000.00	1 (10.0)	9 (90.0)	0.4 (0.0 - 2.9)	0.335
> 150,000.00	4 (36.4)	7 (63.6)	1.8 (0.5 - 6.7)	0.367
Who buys medication				
Self	40 (31.3)	88 (68.7)	1.0	
Spouse	0 (0.0)	14 (100.0)	-	0.998
Child	2 (10.5)	17 (89.5)	0.3 (0.1 - 1.2)	0.080
Employer/Insurance Co.	0 (0.0%)	4 (100.0)	-	0.999

Table 4 shows association of glycaemic control with diabetes-related characteristics. There was significant difference in glycaemic control between diabetes education acquired over one year prior to study entry versus education acquired 6 months prior to the study, $p = 0.014$ (OR 0.3, 95% CI 0.1 - 0.8), suggesting that glycaemic control was significantly associated with diabetes education acquired over one year prior to study entry.

Table 4: Association of glycaemic control with diabetes-related characteristics

Characteristic	Controlled glycaemia (HbA1c ≤ 7.0%) No. (%)	Uncontrolled glycaemia (HbA1c > 7.0%) No. (%)	OR (95% CI)	P-values
Family history of diabetes				
Yes	21 (27.3)	56 (72.7)	1.0	-
No	21 (23.9)	67 (76.1)	0.8 (0.4 - 1.7)	0.616
Diabetes education/update sessions				
None since diagnosis	2 (15.4)	11(84.6)	0.2 (0.0 - 1.1)	0.061
≤ 6 months prior to the study	27 (23.1)	90 (76.9)	0.3 (0.1 - 0.8)	0.014
7-12 months prior to the study	1 (10.0)	9 (90.0)	0.1 (0.0 - 1.1)	0.060
> 1 year prior to the study	12 (48.0)	13 (52.0)	1.0	-
SMBG, glucometer utilization				
Yes	17 (29.8)	40 (70.2)	1.4 (0.7 - 2.9)	0.349
No	25 (23.1)	83 (76.9)	1.0	-
Anti-diabetic medications used				
Oral hypoglycaemic agent(s)[a]	39 (27.9)	101 (72.1)	1.9 (0.2 - 17.1)	0.554
Insulin monotherapy	1 (16.7)	5 (83.3)	1.0	-
Insulin and metformin combination	2 (10.5)	17 (89.5)	0.6 (0.0 - 7.9)	0.689

aMetformin ± glibenclamide or gliclazide

The study population demonstrated a high overall knowledge of diabetes, based on the 14-item MDRTC diabetes knowledge test. Mean DKT score (± SD) was 64.3 ± 15.3%, which was satisfactory; range 14% - 93%. Majority (90.9%) of the patients obtained DKT score ≥ 50%. These were presumed to have good knowledge of diabetes. Less than one tenth (9.1%) of the patients failed the diabetes knowledge test (DKT score < 50%), suggesting poor knowledge of diabetes. The female patients (62.4%) comprised the majority of the patients with good knowledge of diabetes. Other characteristics are as shown in Tables 5 and 6.

Table 5 shows association of knowledge of diabetes with socio-demographic characteristics. Female gender was associated with good knowledge of diabetes, p = 0.025 (OR 3.3, 95% CI 1.1 - 9.8). There was statistically significant difference in the knowledge of diabetes between patients who were unemployed and those in formal employment, p = 0.045 (OR 0.3, 95% CI 0.1-1.0), suggesting that unemployment was associated with good knowledge of diabetes. A trend towards poor knowledge of diabetes among patients with family annual income in excess of Kshs 150,000.00 (US$1,402) was noted, but this was not statistically significant, p= 0.054.

Table 5: Association of knowledge of diabetes with socio-demographic characteristics

Characteristic	Knowledge of diabetes, *n* (%) Good (DKT ≥ 50%)	Poor (DKT < 50%)	OR (95% CI)	P-value
Gender				
Male	47 (83.9)	9 (16.1)	1.0	
Female	103 (94.5)	6 (5.5)	3.3 (1.1 - 9.8)	0.025
Marital status				
Single	20 (95.2)	1 (4.8)	2.3 (0.3 - 18.4)	0.439
Married	114 (89.8)	13 (10.2)	1.0	
Separated/divorced	4 (80.0)	1 (20.0)	0.4 (0.0 - 4.4)	0.497
Widowed	12 (100.0)	0 (0.0)	-	0.999
Level of formal education				
No education Primary education	9 (81.8)	2 (18.2)	1.0	
Secondary education	91 (93.8)	6 (6.2)	3.4 (0.6 - 19.2)	0.171
Tertiary education	39 (88.6)	5 (11.4)	1.7 (0.3 - 10.4)	0.548
	11 (84.6)	2 (15.4)	1.2 (0.1 - 10.5)	0.855
Employment				
Unemployed	61 (93.8)	4 (6.2)	1.0	
Formal employment	23 (79.3)	6 (20.7)	0.3 (0.1-1.0)	0.045
Informal employment	66 (93.0)	5 (7.0)	0.9 (0.2-3.4)	0.835
Family annual income (KES)				
≤ 50,000.00	104 (92.0)	9 (8.0)	1.0	
50,001.00 -100,000.00	29 (93.5)	2 (6.5)	1.3 (0.3 - 6.1)	0.779
100,001.00 -150,000.00	9 (90.0)	1 (10.0)	0.8 (0.1 - 6.9)	0.882
> 150,000.00	8 (72.7)	3 (27.3)	0.2 (0.1 - 1.0)	0.054
Who buys medication				
Self	118 (92.2)	10 (7.8)	1.0	
Spouse	13 (92.9)	1 (7.1)	1.1 (0.1-9.3)	0.929
Child	16 (84.2)	3 (15.8)	0.5 (0.1-1.8)	0.263
Employer/Insurance Co.	3 (75.0)	1 (25.0)	0.2 (0.0-2.7)	0.254

* 1US$ = KShs. 107

Association of knowledge of diabetes with diabetes-related characteristics is presented in Table 6. Knowledge of diabetes was not associated with diabetes-related characteristics, $p > 0.05$. Although there was a trend towards poor knowledge of diabetes among patients not exposed to diabetes education since diagnosis, this was not statistically significant, $p = 0.086$.

Table 7 shows association of glycaemic control with knowledge of diabetes. Knowledge of diabetes was not significantly associated with glycaemic control, $p = 0.910$ (OR 0.9, 95% CI 0.3 - 3.1). Knowledge deficits, based on DKT questions incorrectly answered by more than 50% of the patients, were identified in areas related to diet, treatment of hypoglycaemia and effect of physical activity on blood glucose.

Table 6: Association of knowledge of diabetes with diabetes-related characteristics

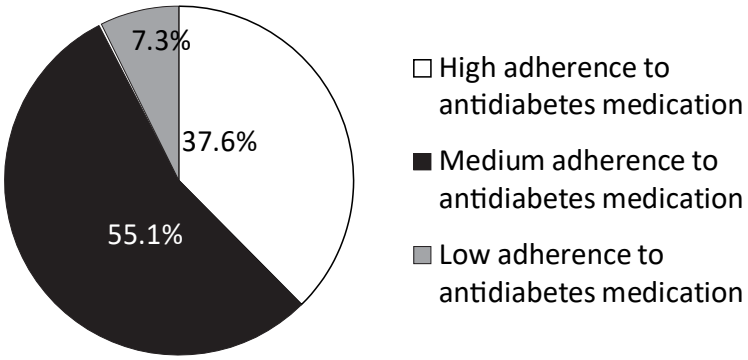
Characteristic	Knowledge of diabetes, *n* (%) Good (DKT ≥ 50%)	Poor (DKT < 50%)	OR (95% CI)	P-value
Family history of diabetes				
Yes	69 (89.6)	8 (10.4)	1.0	
No	81 (92.0)	7 (8.0)	1.3 (0.5-3.9)	0.587
Diabetes education/update sessions				
None since diagnosis	9 (69.2)	4 (30.8)	0.2 (0.0-1.3)	0.086
≤ 6 months prior to recruitment	109 (93.2)	8 (6.8)	1.2 (0.2-5.9)	0.837
7-12 months prior to recruitment	9 (90.0)	1 (10.0)	0.8 (0.1-9.7)	0.849
> 1 year prior to recruitment	23 (92.0)	2 (8.0)	1.0	
SMBG, glucometer utilization				
Yes	52 (91.2)	5 (8.8)	1.0	
No	98 (90.7)	10 (9.3)	0.9 (0.3-2.9)	0.918
Type of treatment				
Oral hypoglycaemic agent(s) [a]	124 (91.2)	12 (8.8)	1.0	
Insulin monotherapy	4 (100.0)	0 (0.0)	-	0.998
Insulin and metformin	20 (95.2)	1 (4.8)	0.6 (0.1-5.1)	0.603

[a]Metformin ± glibenclamide or gliclazide

Table 7: Association of glycaemic control with knowledge of diabetes

Characteristic	Controlled glycaemia (HbA1c ≤ 7.0%) *n* (%)	Uncontrolled glycaemia (HbA1c > 7.0%) *n* (%)	OR (95% CI)	P-value
Level of diabetes knowledge				
Good knowledge	38 (25.3)	112 (74.7)	0.9 (0.3-3.1)	0.910
Poor knowledge	4 (26.7)	11 (73.3)	1.0	

Figure 2: Adherence to medication of study patients as assessed by modified Morisky medication adherence scale



Adherence to medication among the study patients is shown in Figure 2. The level of adherence to medication was low, at 37.6%, female patients comprising 23.7%. Non-adherence to medication was high (62.4%) among these patients, female patients accounting for 42.4%. The mean age of patients with good adherence to medication was 56.1 years, while that for poor adherence to medication was 55.5 years. The median duration of diabetes for patients with adherence to medication and for patients with non-adherence to medication were 4.5 years and 5.1 years respectively.

Table 8 shows association of adherence to medication with socio-demographic characteristics of the patients. Analysis showed significant difference in non-adherence to medication between family annual income of less Ksh. 50,000.00 and Ksh. 50,001.00 - 100,000.00, p = 0.043 (OR 2.3, 95% CI, 0.0 - 5.2). There was also significant difference in non-adherence to medication between taking of medication provided by spouses of patients versus that of medication bought by patients, p = 0.030 (OR 0.1, 95% CI, 0.0 - 0.8). Family annual income of less than Ksh. 50,000.00 and provision of medications by spouses of patients were significantly associated with non-adherence to medication.

Table 8: Association of adherence to medication with socio-demographic characteristics

Characteristic	Adherence n (%)	Non-adherence n (%)	OR (95% CI)	P-value
Gender				
Male	23 (41.1)	33 (58.9)	1.0	
Female	39 (35.8)	70 (64.2)	0.8 (0.4 - 1.6)	0.507
Marital status				
Married	46 (36.2)	81 (63.8)	1.0	
Single	11 (52.4)	10 (47.6)	2.2 (0.8 - 5.6)	0.115
Separated/divorced	1 (20.0)	4 (80.0)	0.4 (0.1 - 4.1)	0.469
Widowed	4 (33.3)	8 (66.7)	0.7 (0.2 - 2.2)	0.583
Level of formal education				
No education	5 (45.4)	6 (54.6)	1.0	
Primary education	32 (33.0)	65 (67.0)	0.6 (0.2 - 2.1)	0.413
Secondary education	19 (43.2)	25 (56.8)	0.9 (0.2 - 3.4)	0.892
Tertiary education	6 (46.1)	7 (53.9)	1.0 (0.2 - 5.2)	0.973
Employment				
Unemployed	22 (33.8)	43 (66.2)	1.0	
Formal employment	13 (44.2)	16 (55.2)	1.6 (0.7 - 4.0)	0.294
Informal employment	27 (38.0)	44 (68.0)	1.2 (0.6 - 2.5)	0.577
Family annual income (KES)				
≤ 50,000.00	39 (34.5)	74 (65.5)	1.0	
50,001.00 - 100,000.00	17 (54.8)	14 (45.2)	2.3 (1.0 - 5.2)	0.043
100,001.00 - 150,000.00	1 (10.0)	9 (90.0)	0.2 (0.0 - 1.7)	0.147
> 150,000.00	5 (45.4)	6 (54.6)	1.6 (0.5 - 5.5)	0.472
Who buys medication				
Self	55 (43.0)	73 (57.0)	1.0	
Spouse	1 (7.1)	13 (92.9)	0.1 (0.0 - 0.8)	0.030
Child	6 (31.6)	13 (68.4)	0.6 (0.2 - 1.7)	0.350
Employer/Insurance Co.	0 (0.0)	4 (100.0)	-	-

Table 9 is a summary of association of adherence to medication and diabetes-related characteristics. Statistically significant difference was noted in non-adherence to medication between diabetes education gained 7-12 months prior to the study entry and diabetes education gained more than one year, p = 0.031 (OR 0.1, 95% CI 0.1 - 0.8). Diabetes education gained 7-12 months prior to study entry was associated with non-adherence to medication. There were significant differences in non-adherence to medication between use of one OHA and two OHAs, p = 0.004 (OR 0.3, 95% CI 0.1 - 0.7) and use of one OHA and combination therapy of insulin and OHA, p = 0.001 (OR 0.1, 95% CI 0.0 - 0.3). Treatment with two OHAs and combination therapy of insulin and one OHA was associated with non-adherence to medication.

Table 9: Association of adherence to medications with diabetes-related characteristics

Characteristic	Adherence No. (%)	Non-adherence No (%)	OR (95% CI)	P-value
Family history of diabetes				
Yes	32 (41.6)	45 (58.4)	1.0	
No	30 (34.1)	58 (65.9)	0.7 (0.4 - 1.4)	0.324
Diabetes education/update sessions				
None since diagnosis	4 (30.8)	9 (69.2)	0.4 (0.1 - 1.4)	0.146
≤ 6 months prior to the study	43 (36.7)	74 (63.3)	0.5 (0.2 - 1.1)	0.079
7-12 months prior to the study	1 (10.0)	9 (90.0)	0.1 (0.0 - 0.8)	0.031
> 1 year prior to the study	14 (56.0)	11 (44.0)	1.0	
SMBG, glucometer utilization				
Yes	25 (43.9)	32 (56.1)	1.0	
No	37 (34.3)	71 (65.7)	0.7 (0.4 - 1.3)	0.227
Type of treatment				
OHA (1) – metformin only	17 (68.0)	8 (32.0)	1.0	
OHAs (2)[a]	41 (35.7)	74 (64.3)	0.3 (0.1 - 0.7)	0.004
Insulin monotherapy	2 (33.3)	4 (66.7)	0.2 (0.0 - 1.6)	0.134
Insulin/metformin combination	2 (10.5)	17 (89.5)	0.1 (0.0 - 0.3)	0.001

[a]Metformin ± glibenclamide or gliclazide

Association of adherence to medication with glycaemic control and knowledge of diabetes is presented in Table 10. Almost all patients (90.5%) with good glycaemic control had good adherence to medication, while 19.5% of patients with sub-optimal glycaemic control had good adherence to medication. Thirty nine percent of the patients with good knowledge of diabetes and 20% of patients with poor knowledge of diabetes had good adherence to medication. There was no significant association between adherence to medication and glycaemic control, p = 0.061 (OR 0.2, 95% CI, 0.1 - 0.3), There was also no association between adherence to medication and knowledge of diabetes, p = 0.905 (OR 1.1, 95% CI, 0.3 - 3.4).

Table 10: Association of adherence to medication with glycaemic control and knowledge of diabetes

Characteristic	Adherence No. (%)	Non-adherence No. (%)	OR (95% CI)	P-value
Glycaemic control				
Controlled glycaemia (HbA**1**c < 7.0%)	38 (23.0)	4 (2.4)	1.0	
Uncontrolled glycaemia (HbA**1**c > 7.0%)	24 (14.5)	99 (60)	0.2 (0.1 - 0.3)	0.061
Patient knowledge of diabetes				
Good knowledge (DKT ≥ 50%)	59 (35.8)	91(55.2)	1.1 (0.3- 3.4)	0.905
Poor knowledge (DKT < 50%)	3 (1.8)	12 (7.3)	1.0	

Discussion

Despite high patient knowledge of diabetes in this study, there was evidence of low glycaemic control and adherence to medication, implying that knowledge did not translate into good diabetes practice, particularly adherence to medication for good glycaemic control. Thirty five percent of the patients had HbA1c level > 10%, reflecting possible patient non-adherence to medication and or inertia in management of diabetes by resident clinicians. Twenty per cent of the patients had disparities in HbA1c and fasting blood glucose levels, demonstrating the need to employ HbA1c assay in monitoring long-term glycaemic control as compared to blood glucose tests whose results frequently vary with food intake.

Studies in both developing and developed countries have documented sub-optimal glycaemic control among most patients with T2DM (8-13). Local studies at Kenyatta National Hospital (KNH), a university teaching and tertiary referral hospital in Nairobi, have shown low levels of glycaemic control (8-12), ranging from 13.9% to 39.5% (8,9). Vaghela (10) and Omari (11) in KNH, documented glycaemic control of 29.9% and 29.5% respectively. These levels were comparable with the finding in this study. Mwavua *et. Al* (12) in 2016 reported a much lower level of glycaemic control of 17% in a multicentre comparative study of the quality of care and glycaemic control among ambulatory patients with T2DM at KNH and Thika District Hospital (a peripheral urban secondary health facility). This suggested possible widespread sub-optimal glycaemic control countrywide. A cross-sectional multicentre study on glycaemic control among patients with T2DM in seven European countries from 2006 - 2007 by Alvarez *et al* (13) reported glycaemic control among 25.5% of the patients, a level similar to that noted in our study. Otieno *et al* (9) in a study in KNH attributed poor glycaemic control largely to poverty. In our study, poor glycaemic control was similarly due to low economic status. This impacted access to healthcare services and hence glycaemic control. Factors associated with good glycaemic control in this study were diabetes education acquired over one year prior to study entry, single (marital) status and formal employment.

Knowledge of diabetes in this study was high. It was comparable to the level of knowledge of diabetes of 77.2% in a study at KNH by Omari *et al* (11). In the study at KNH the high level of knowledge of diabetes was as attributed to the DSME offered (11). In this study, the high knowledge of diabetes (90.9%) similarly reflected quality of DSME offered at the healthcare facility. In contrast, Odili *et al* (14) in Nigeria, in a study using DKT, reported poor knowledge of diabetes (mean DKT score 39.5 % ± 16.7 %), which was attributed to patient diabetes education and cultural beliefs about diabetes. Factors associated with good knowledge of diabetes were female gender and unemployment. Association of knowledge of diabetes with female gender was possibly related to the postulated better health-seeking behaviour of females (21). The association of knowledge of diabetes with unemployment was likely due to relatively ample time the unemployed patients had to interact and acquire knowledge of diabetes; most patients who declined to participate in the study were the employed, citing need not to delay to report back to work.

Knowledge of diabetes was not associated with glycaemic control. This was not unusual as knowledge of diabetes is only a component of diabetes care, and demands of glycaemic control stretch beyond knowledge of diabetes. Dissociation of knowledge of diabetes and glycaemic control has been observed in various studies. Studies by Omari *et al* (11) and Islam *et al* (22) reported similar findings. Islam *et al* (22) in Bangladesh, attributed their findings to lack of access to healthcare by the general population. In our study, this was because of poor access to healthcare services and non-adherence to medication largely due to high healthcare costs and limited income of the patients.

Knowledge deficits in diabetes were identified in areas related to diet, physical activity and treatment of hypoglycaemia. Appropriate diet and physical activity, which constitute lifestyle modification in diabetes management, promote weight loss and

improve glycaemic control (1,2). Knowledge deficits in diet and physical activity in this study population suggested probable association of sub-optimal glycaemic control with unsuitable dietary practices and physical activity. Maina *et al* (23) in Kenya, observed knowledge gaps in adherence to both dietary practices and physical exercises, consistent with the findings in our study, suggesting possible widespread prevalence of these deficits among patients with diabetes in this country. Al-Rasheedi (24) in Saudi Arabia, also noted significant association of poor glycaemic control with poor adherence to dietary advice and physical activity. Knowledge deficits in our study were attributed to lack of knowledge about benefits of suitable diet and physical activity in glycaemic control. The deficit in treatment of hypoglycaemia was of critical significance in this study population. It posed a huge challenge, as 35.4% of the patients had HbA1c level >10%, and essentially required insulin-based therapy, which potentially predisposes to hypoglycaemia with risk of loss of life, if not promptly recognised and managed. This deficit was probably due to lack of emphasis on treatment of hypoglycaemia in DSME program and or understanding of consequences of failure to recognize and treat hypoglycaemia.

The level of non-adherence to medication was high (62.4%). Comparatively, this was higher than that reported in KNH by Omari *et al* (11) (39.8%), and Pascal *et al* (25) in Eastern Nigeria in 2012. It was lower than that in the study by Sankar *et al* (26) in rural Kerala, India. Pascal *et al* (25) documented financial constraint as a factor associated with non-adherence to medication. In our study, non-adherence to medication was similarly due to financial constraints, largely resulting from low income status.

There was no statistically significant association of non-adherence to medication with glycaemic control and knowledge of diabetes. Factors associated with non-adherence to medication were low family income, diabetes education, multiple anti-diabetes drug regimen and who bought medication (person or entity). Association of non-adherence to medication and low family income was possibly due to inability to obtain medication because of financial limitations. In a study in Kerala, India, Shaimol *et al* (27) noted low-income patients were less adherent to prescribed therapy than high-income patients. Association of non-adherence to medication and diabetes education gained 7-12 months prior to study entry (compared to diabetes education obtained more than one year) was probably due to inadequate internalized knowledge of diabetes. Sankar *et al* (26) in India, attributed high rate of non-adherence to limited diabetes education and low per capita monthly expenditure, among other factors. Association of non- adherence to medication and multiple anti-diabetes drug regimens was possibly due to inability to afford high cost of medication.

Given the evident dissociation of glycaemic control and knowledge of diabetes, it was necessary that factors affecting glycaemic control, including but not limited to non-adherence to medication and identified knowledge deficits, should be promptly addressed by the relevant authorities so as to facilitate adequate glycaemic control, as re-enforcement of quality knowledge of diabetes is maintained. Importantly, provision of free healthcare service to the unemployed and persons in low income brackets, from a publicly funded national healthcare system should be considered. Strategies to identify and resolve other potential barriers to glycaemic control should be employed to augment adequate glycaemic control in this study population with scarce financial resources.

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